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Australian Residential Solar Feed-in Tariffs: Industry Stimulus or Regressive form of Taxation?

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Abstract: Feed-in Tariffs (FiT) for residential photovoltaic solar technologies are available in most Australian jurisdictions. Financial incentives under FiT are in addition to those provided by the Small-Scale Renewable Energy Scheme which forms part of the national 20% Renewable Energy Target. Little attention has been paid to the welfare impacts of FiT on retail electricity prices and social policy objectives. Our analysis indicates that current FiT are a regressive form of taxation. By providing estimates of household impact by income groupings, we conclude that wealthier households are beneficiaries and the effective taxation rate for low income households is three times higher than that paid by the wealthiest households.

I. INTRODUCTION

Investment growth in renewable generating technologies continues to increase year-on-year. In 2010, global investment in renewable energy totalled $243bn, a 30% increase on the 2009 result (Bloomberg 2011). However, despite this growth and continuing reductions in the cost of renewable technologies, an unambiguous cost gap exists between traditional fossil fuel generation and renewable generating capacity. Government-initiated policies have been introduced to bridge this gap, enabling the private sector to competitively invest in renewable energy.

In Australia, the appetite for small-scale solar photovoltaic (PV) units has increased substantially as the costs of the technology have declined, in part through currency appreciation, while the level of government-initiated funding has also increased. ACIL Tasman (2010) noted that the trajectory of household installations is heading towards a 17% penetration rate by 2013.

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The funding mechanisms to attract this uptake have and continue to be subject to considerable debate, with resulting volatility in both the availability and absolute level of subsidies.

Presently, there are two forms of funding assistance available to stimulate growth in the installation of residential solar PV systems. The first is an upfront grant to reduce the initial capital cost faced by households. This is provided by the federal government; the Small-Scale Renewable Energy Scheme (SRES), legislated in 2010, provides a fixed upfront incentive of about $5000 which reduces the roughly $8000 total capital cost substantially. The incentives under SRES have been designed by legislation to decay over time, and to adjust downwards in circumstances where technology costs cross below a floor price.

The second form of funding in addition to the upfront SRES capital grant is premium solar PV Feed-in Tariffs (FiT). Most States and Territories offer the owners of small-scale solar PV installations a FiT that has the effect of increasing the amount a household receives for electricity generated, and does so by a non-trivial amount. A number of jurisdictions have implemented Net FiT, whereby only electricity generated above a household's half-hourly consumption level receives the premium rate. The ACT and NSW on the other hand have implemented a more generous Gross FiT, where the premium rate is applied to all electricity generated, regardless of household consumption.

An often overlooked component of both capital grant and FiT policy settings relates to the manner in which they are funded. In the Australian context, the costs associated with paying the SRES capital subsidies and higher prices to solar PV system owners through FiT are in all cases spread across all electricity consumers. Surprisingly, analysis of this funding mechanism seems to have been entirely neglected by policy makers. We are not aware of any analysis that has been undertaken to assess the combined effects of federal capital subsidies and state-based premium FiT arrangements.

In this article, we focus on FiT policies because they provide windfall funding to specific asset owners, who then *internalise the benefits* of the solar PV system. In simple terms, the asset owner obtains exclusive access to the energy produced by the system, which reduces their future exposure to other policy objectives like carbon prices and rising electricity network prices. In contrast other (non solar pv asset-owning) electricity consumers essentially finance the premium FiT and the capital grants under the SRES, and will face the full exposure of other policy objectives such as carbon prices.

This set of cross-subsidies is in dramatic contrast to utility-scale renewable portfolio standards (such as the Large Scale Renewable Energy Target) or FiT policies where energy production is subsidised but the energy produced is consumed by all grid-connected customers.

This article is structured as follows; In Section II, we present unit cost estimates of small-scale solar PV applications and contrast these with utility-scale plant costs. Section III outlines the iterations of public policy development over the previous decade in relation to stimulating the uptake of residential solar PV. Section IV presents our criteria for assessing small-scale renewable energy policy design and outcomes. Quantitative evidence is presented in Section V to assess FiT policies against the criteria outlined in Section IV. Our policy recommendations and concluding remarks follow.

II. THE UNIT COST OF SMALL-SCALE SOLAR PV AND UTILITY-SCALE GENERATING TECHNOLOGIES

The cost of residential or small-scale solar PV is significant when compared with alternative energy sources at utility scale. In equation 2.1, we set out the method for calculating the unit cost or Long Run Marginal Cost (LRMC, expressed in \$/MWh) of a solar PV system equipped to an average Australian house.

$$LRMC_j = \left[\frac{PV\left(\sum_{i=1}^{I} Capex_j\right)}{PV\left((k_j \times ACF_j \times 8760) \times \gamma CPI_{(t)}\right)} \right] / \left(1 - x_j\right) \tag{1}$$

In our analysis, the total installed capital cost of the j^{th} solar PV unit is given by $Capex_j$. In all following calculations, we have assumed $Capex_j$ to be \$8000 whereby the basic kit installation has installed capacity k_j equal to 1.5kW. Additionally, we assume an annual capacity factor ACF_j of about 16% which is relevant for a household in Sydney.[2] This results in total system output of 2.1 MWh per annum after multiplying capacity k_j by the 8760 hours in a year and by capacity factor ACF_j. Solar PV losses x_j are also accounted for and have been set at 7%. We use a household pre-tax discount rate of 10% to conduct Present Value calculations, and use a 2.5% inflation rate for $CPI_{(t)}$. We also make use of the term γ to discount our inflation rate at ¾ of the annual consumer price index, which in turn reflects productivity gains in the industry which, over time, manifests in unit pricing.

We have produced two primary estimates of $LRMC_j$ for the 1.5kW system. Our first estimate assumes a total useful equipment life of 25 years in line with manufacturers' expectations. Our second estimate assumes an 'economic life' of about seven years, which is reflective of the time period over which the most popular FiT policies are paid (see Section IV). Based on equation 2.1 and the parameters outlined about, the LRMC of a 1.5kW solar PV for household use is as follows:

- LRMC with a 25-year useful life: \$422/MWh for all output[3]
- LRMC with a 7-year economic life: \$785/MWh for all output

We noted earlier a \$5000 capital grant is currently available via the SRES. When this capital grant is incorporated into equation 2.1 as an offset to $Capex_j$, the LRMC estimates facing households predictably plunge:

- LRMC, 25-year useful life, \$5,000 grant: \$158/MWh for all output
- LRMC, 7-year economic life, \$5,000 grant: \$294/MWh for all output

As noted earlier, SRES capital grants will diminish in value over time commencing 1 July 2011. Regardless, it is helpful to contrast these generalised LRMC estimates with utility-scale generating technologies, where the cost of capital is materially higher.

2 Figures obtained from the SGU calculator. Available online: https://www.rec-registry.gov.au/sguCalculatorInit.shtml, accessed in February 2011.

3 Sensitivities to our \$8000 price were also calculated. If the cost of the system was increased to \$9000 the LRMC would be about \$475/MWh and if reduced to \$7000, the LRMC would be about \$370/MWh.

Figure 1: Generalised LRMC of Utility-Scale Energy Technologies

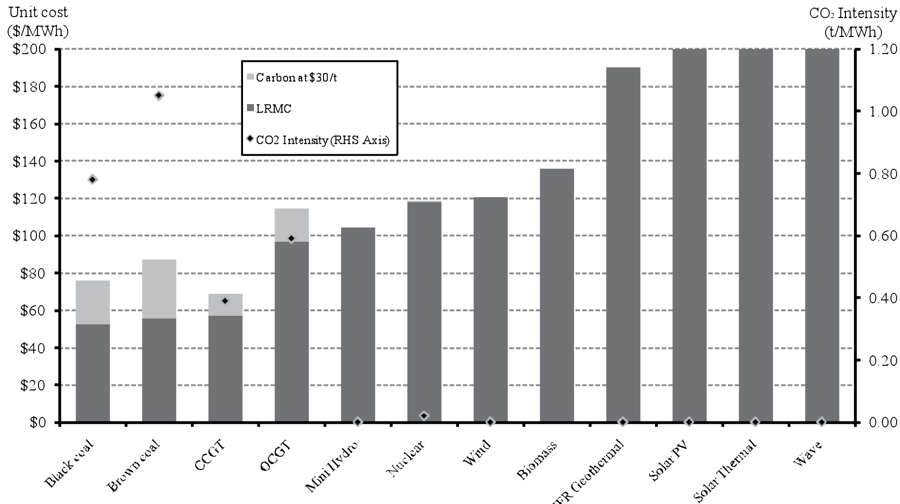


Figure 1 which has been drawn from Simshauser (2011) outlines the generalised LRMC for both conventional and renewable generation plant where the marginal efficiency of capital is assumed to be 12% on a pre-tax basis. It is clear that our LRMC estimates of small-scale solar PV are substantially more expensive than competing renewable energy technologies such as wind ($120/MWh) and biomass ($135/MWh), and traditional thermal options like coal and gas. Note that the Solar PV application included in *Figure 1* represents a utility-scale application of approximately 100MW installed capacity.

There are several implications from *Figure 1*, and they are important. Firstly, Simshauser, Nelson and Doan (2011a) noted that transmission and distribution charges in NSW in FY08 were less than $45/MWh, although given current capital programs will rise to about $91/MWh by 2015.[4] But even after adding $91/MWh to the generalised LRMC results in *Figure 1* to account for transmission and distribution network charges, estimates from the primary utility-scale renewable generating technologies (i.e. wind, biomass, mini-hydro) represent a much lower cost outcome to achieve renewable output targets, being substantially less than half the cost of small-scale solar PV units.

While not clear, the generalised LRMC estimate for the utility-scale solar PV application in *Figure 1* is about $255/MWh. If solar applications were considered important on policy grounds, then the current solar flagship program appears a more efficient way to drive industry development and investment, especially given that capital cost k_j of utility-scale solar PV is expected to continue to reduce over time (ACIL Tasman 2009).

What is clear from the above analysis is that grid-connected utility-scale renewables have substantially lower costs than residential small-scale solar PV. When considered in isolation of other criteria, this indicates a poor public policy rationale for government support of residential solar PV. Assessing other criteria is beyond the scope of this article but nevertheless, if the technology is to be adopted by consumers, material policy incentives need to be put in place.

4 For details of network charges in Sydney, see Simshauser, P., T. Nelson, and T. Doan (2011a).

III. SUBSIDIES AVAILABLE FOR SMALL-SCALE SOLAR PV

The economics of solar PV aside, as we noted earlier there are policies in place to stimulate investment in small-scale solar PV systems, and some of these have been operative for over a decade in Australia. We have categorised funding policies into two groups: Commonwealth polices; and specific States and Territories policies. An overview of the structure and evolution of these is outlined below.

The Federal Photovoltaic Rebate Program started in 2000, offering $4,000 rebates for installations of small-scale PV (1.5 kW systems).[5] As an on-budget program that often experienced over-subscription, the value and overall cap for participation was subject to considerable variation. Initially designed by the Howard Liberal/National Coalition Government, it was inherited by the incoming Rudd Labour Government in 2007. At this point, it was renamed the Solar Homes and Communities Program with the individual rebate increased to $8,000 (at which time the cost of a 1.5kW solar PV was considerably higher than the current estimates provided in Section II). Subsequent further over-subscription was addressed by 'means testing' which had the effect of limiting the eligibility of households to those with a taxable income of under $100,000. Presumably to the surprise of policy makers, applications increased tenfold between FY08 and FY09. As a result, on 9 June 2009 the Government announced the policy's discontinuation "effective immediately" (AI, 2010). A substitute was introduced shortly after which involved amendments to the 2% Mandatory Renewable Energy Target (MRET).

The MRET commenced in 2001, aiming to satisfy an additional 2% of Australia's electricity consumption with renewable energy. As a market based mechanism, Renewable Energy Certificates (RECs) were issued for several different technologies, including small-scale solar PV. To minimise transaction costs and for administrative ease, RECs were 'deemed' (i.e. created upfront) based on an estimate of the first 10 years of electricity generation. This 'deeming' process delivered financial support of about $1,000 for a 1.5kW installation under the MRET. In the broader policy context, MRET support was minimal compared to the existing Rebate Program. It is worth noting that as a least-cost mechanism, the technologies that satisfied the MRET in practice were primarily alternatives to PV, such as utility-scale mini-hydro, wind and biomass.

At the time that the Solar Homes and Communities Program was discontinued, the Commonwealth Government was drafting legislation to amend the MRET and increase Australia's Renewable Energy Target to 20% (RET). The coincidental timing resulted in the government markedly increasing the incentives for small-scale solar PV installations by a feature known as the 'Solar Credits Multiplier'. This was passed with the amendment bill that established the 20% target by 2020.

The Solar Credits Multiplier increased the number of RECs for installation of an eligible solar PV system five-fold, amounting to an upfront subsidy of about $5,000 for a 1.5kW installation. The Solar Credits Multiplier is legislated to decay over time, and provides for Ministerial intervention to reduce the multiplier earlier if electricity prices are adversely affected, or the costs of technology reduce (*Renewable Energy (Electricity) Act 2000*). The end result

[5] www.climatechange.gov.au accessed February 2011

of this reform is that industry can enter contracts which 'firm up' the cost (and subsidy level) of installing small-scale solar PV.

A key observation of the evolution of policy at the Federal level is the shift which occurred across both sides of politics from an on-budget funding program, to an off-budget scheme that smears the costs of the subsidy across all electricity consumers. As the costs of the subsidies increased, it became increasingly challenging for Government to subsidise small-scale solar PV, instead opting for a preferred off-budget approach where costs were diluted across the roughly $16 billion annual sales of energy across Australia.

3.1 State and Territory Government Policies

The history of direct incentives for small-scale solar PV installations appears to be much shorter at the state/territory level. Whilst some jurisdictions for a number of years had required electricity retailers to buy energy exported by small-scale solar PV installations, the rate of payment on a kWh basis was largely left to market forces to determine.

In 2007, a number of states began contemplating legislation for the introduction of premium FiT for small-scale solar PV generation. South Australia was the first state to do so, in 2008. At the time of writing, practically all jurisdictions have introduced a premium FiT for small-scale solar PV. *Table 1* provides a summary of the differing approaches:

Table 1: Overview of Feed-in Tariffs in Australia

State	Max installation size	Rate $/MWh (gross or net payment)	Duration	Comment
Vic	5kW	$600 (net)	15 years	Commenced in 2009 – FiT can be credited on account or paid cash.
SA	30kW	$540 (net)	20 years	The rate is capacity-determined with reduced rates for larger capacity increments.
NSW	10kW	$600 (gross)	7 years	A 2010 review reduced the rate to $0.20. Subsequent announcement that new installations would not receive the rate in 2011.
QLD	30kW	$440 (net)	20 years	The rate is capacity-determined with reduced rates for larger capacity increments.
ACT	30kW	$450 (gross)	20 years	The rate was reduced after review by the independent regulator concluded a payback period of 7 years was acceptable

Source: State Governments

Recall from Section II that the unit cost of a small-scale solar PV system, at an initial acquisition cost of $8000 and an upfront capital grant of $5000 was $158/MWh over a 25-year useful life, or roughly double that for a household seeking a seven-year return. Unsurprisingly, the premium FiT policies outlined in *Table 1* proved to be very attractive for consumers, especially the now disbanded NSW $600/MWh Gross FiT. Indeed, following NSW's Gross FiT implementation, the payback period for a 1.5kW system was just two years once the capital subsidy arising from the RET's deeming process was taken into account.

IV. ASSESSMENT CRITERIA FOR SMALL-SCALE STIMULUS POLICY

Before examining the assessment criteria for FiT, it is worth contrasting small-scale stimulus renewable policies with large-scale renewable energy portfolio standards or trading schemes. There is a critical distinction between the two from a welfare perspective. Large-scale renewable energy portfolio standards or trading schemes result in investment and subsequent production of renewable energy that is distributed to all consumers. In other words, the benefits, and the costs of these policies, accrue to all electricity consumers.

On the other hand, small-scale stimulus policies, such as residential solar PV feed-in tariffs, result in subsidy costs being socialised and benefits that are comprehensively internalised by the household which takes advantage of the capital subsidy and FiT arrangements. Consider for example a scenario where in 10 years time, the cost of gas has increased to $10/GJ and the price of carbon has risen to US$60/t. Such a scenario would result in thermal power being higher cost than a wind turbine generator, for example. In the event, historic investments made under the Large-Scale Renewable Energy Target (LRET) would provide low cost, zero emission power to the main grid for the benefit of all consumers. The benefits would primarily arise through the zero fuel cost and carbon exposure of that particular technology relative to expensive thermal generation.

On the other hand, a wealthy household who installed a 1.5kW solar PV under the current capital grant and FiT arrangements would have a substantially lower exposure to the gas and carbon price; but this will have primarily been paid for via the capital subsidies and FiT arrangements, which in turn has been fundamentally financed by other electricity consumers.

These comparative outcomes between the SRES and the LRET are completely unambiguous. As such, great emphasis should be placed on examining the policy objective of equity when considering small-scale stimulus policies, because the benefits of the policy accrue only to the household that installs the system, while the costs are dispersed across the remaining consumer base.

In the interests of ensuring appropriate support for the deployment of small-scale renewable energy technologies, the Council of Australian Governments (COAG 2009) in November 2009 endorsed the *National Principles for Feed-in Tariff Schemes*. Stating that renewable exported energy should receive payment that is of at least equal value to the energy in a relevant market at a comparative time of supply, the principles cover many aspects of design for a premium FiT. In particular, the principles address the approach of funding for FiT policies and the potential for disproportionate impacts on consumers. The principles also notionally address one of the key barriers to broader distributed generation uptake, that is, appropriate recognition of avoided network use as valued at the time of generation.

Given that governments have made the decision to stimulate the deployment of small-scale solar PV applications, evidently for reasons other than least-cost renewables deployment, the policy objective functions should be clearly defined. In our view, optimal objectives should include: a stable localised industry development program; increasing renewable energy generation output; encouraging households to adopt cleaner energy sources; and ensuring that the policy's requisite funding source is raised in an equitable manner given the very private benefits that accrue to scheme participants. Given these objective functions, we consider that there are three core criteria required to screen FiT designs:

- Equitable source of funding for FiT subsidies: The key issue here is whether a policy's funding source is progressive or regressive in nature. As noted above, small-scale renewable stimulus policies result in very private benefits that are comprehensively internalised by the participating household. The fairness of such a policy should therefore be based upon whether its funding method is progressive or regressive.
- Long-term industry development: The structure of any FiT must ultimately provide for smooth growth in the demand of solar PV units, and subsequently, local industry development capacity. Given the very material increase in solar PV investments, with US$60 billion invested globally in 2010[6] alone, policy settings should be designed to accommodate predictable changes in technology costs and price movements in the energy sector, including a future price on carbon.
- Capture of distributed generation benefits: The structure of FiT should capture any benefits of reduced network congestion/augmentation that distributed generation can deliver. This should include the value of time-of-use/generation, albeit where a genuine benefit exists.

Our view is that these three criteria better reflect the approach that public policy should take in terms of cost burden, and to accommodate the realities of distributed generation feeding into the local distribution network.

V. ASSESSMENT OF FIT POLICIES AGAINST THREE PUBLIC POLICY CRITERIA

In this Section, we provide a detailed assessment of whether FiT policies within Australia satisfy the three criteria outlined in Section IV.

5.1 Is the Policy's Funding Progressive or Regressive in Nature?

An often overlooked aspect of FiT policies relates to an assessment of the incidence of effective taxation. State and Territory governments do not collect explicit taxes to raise revenue to pay for premium FiT schemes. This task has been handed to the electricity industry. Suppliers of electricity recover the costs of all FiT participants by charging all end-use consumers. Most fundamentally, the effect of this is that consumers who do not benefit from being paid a FiT provide a subsidy to those customers that have installed solar PV units. This is therefore an *outsourced* form of taxation whereby the costs of State Government policy are recovered

[6] Bloomberg (2011) noted that $89 billion had been invested in solar technologies during 2010, with $60 billion of this relating to roof-top applications, especially in Germany, US, Italy and others.

from electricity consumers in proportion to how much electricity they use, and irrespective of household income.

We have analysed the effective rate of taxation for three distinct policy types: Gross FiT (GFiT), Net FiT (NFiT) and upfront capital subsidies. Each of these policies has been modelled utilising data specific to NSW for calendar year 2010. This is because a GFiT was in place during much of this period, and in the event, incentivised an enormous uptake of small-scale solar PV units by households and small businesses. Our three scenarios use the following assumed policy parameters:

- A GFiT of $600 per MWh paid for all output produced by a solar PV unit for seven years from 2010[7];
- A NFiT of $440 per MWh paid for 30% of the output produced (i.e. 30% being a surrogate for net household production) by a solar PV unit for seven years from 2010[8]; and
- An up-front capital rebate paid, assumed to be paid by the Commonwealth Government, equivalent in net present value terms to the GFiT over seven years.

In assessing the total costs of the policies, it is first necessary to understand the number of systems installed in NSW and the output they will produce over the eligible seven-year period. The total number of RECs created through the installation of PV systems in NSW in 2010 was 8.8 million.[9,10] Note that this number excludes PV systems that were appropriately ordered during 2010 (and will therefore qualify for the GFiT) but are yet to be synchronised to the electricity grid due to delays in digital metering installation. But in the absence of detailed information on delayed systems, we have opted to utilise publicly available information, acknowledging that our estimates will understate the impacts.

As with equation (2.1), we have structured our model using an assumption that the installed average system size is 1.5 kW, thereby producing 2.1 MWh of electricity annually and creating 155 RECs for each system.[11] Based upon these assumptions and 8.8 million RECs created in aggregate, we can calculate that the number of systems installed in 2010 (TS) using the following equation:

$$TS_{2010} = \frac{8.8million}{155} = 56{,}774 \text{ units or 85MW installed} \qquad (5.1)$$

The total energy output (SO) of these installed systems in year *y* expressed in MWh is presented in equation 5.2:

$$SO_y = 56{,}774\ units * 2.1MWh = 119{,}225MWh \qquad (5.2)$$

7 $600 per MWh has been modelled as the GFiT in New South Wales during 2010 was $600 per MWh

8 $440 per MWh has been modelled as the NFiT in Queensland during 2010 was $440 per MWh

9 Based upon data obtained from the REC registry (https://www.rec-registry.gov.au/home.shtml) in January 2011

10 The actual number of installations in NSW is likely to be significantly higher than the number implied by this source due to the lag in creation of RECs

11 Figures obtained from SGU calculator (https://www.rec-registry.gov.au/sguCalculatorInit.shtml) accessed in February 2011.

The total costs (TC) of the GFiT and NFiT policies can therefore be expressed as per equations 5.3 and 5.4:

$$TC_{GFiT} = NPV\sum_{y}^{7} SO_y * GFiT = NPV\sum_{y}^{7} 119{,}225 * \$600 = \ \$360 \text{ million} \tag{5.3}$$

$$TC_{NFiT} = NPV\sum_{y}^{7} SO_y * GFiT * 0.3 = NPV\sum_{y}^{7} 119{,}225 * \$440 * 30\% = \$79 \text{ million} \tag{5.4}$$

The impact on final electricity tariffs to consumers can then calculated by dividing total costs TC by the existing total aggregate electricity consumption in NSW. Based upon esaa (2010) aggregate consumption data of about 72,000 GWh, we can therefore state that the impact on electricity prices in NSW will be $5.03/MWh under the GFiT policy in place during 2010. To put this into context, power prices in NSW for households in the same period were about $185/MWh. If a GFit policy was substituted for a NFiT policy, the impact on prices would be an increase of $1.11/MWh.

This is the headline impact. However, the impact on individual consumers is a function of both the increase in price and their individual consumption of electricity. To analyse the impact on individual consumer segments, we have made use of the household profile data produced by IPART (2010). In December 2010, IPART published data from a survey of residents in Sydney and the Blue Mountains which provided average annual usage for specific household income groups. *Table 2* outlines the total number of residential customers within each income group based upon 3 million total residential accounts in NSW.[12]

Table 2: Number of NSW Households Broken into Income and Consumption Grouping

Household Income (before tax)	< 4 MWh	4-6 MWh	6-8 MWh	8-12 MWh	12 MWh +
Up to $33,800	324,559	259,051	187,589	142,925	29,776
$33,800 – $62,400	169,723	139,947	151,858	196,522	59,552
$62,400 – $130,000	62,530	92,306	128,037	169,723	160,791
More than $130,000	20,843	71,462	47,642	98,261	119,104
Not disclosed	68,485	59,552	44,664	104,216	62,530

Source: IPART (2010)

The distribution of consumption across income groupings provides useful insights into different household types within NSW. A strong correlation typically exists between household

[12] ESAA (2010) data indicates 3 million residential customers in NSW and the ACT. For simplicity, we have used this number with the limitation that this overstates the number of residential customers and therefore understates the costs per household.

income and electricity consumption (Felder 2010). However, it is not a perfect correlation. A significant proportion of low-income households use only a small amount of electricity (less than 4 MWh), while 3% of households within the lowest income bracket use more than 170% of the average annual consumption within NSW of 7.5 MWh (Simshauser, Nelson and Doan 2011a). This has significant implications in relation to *who pays* for FiT policies.

As an aside, the authors have been made aware of unpublished studies which analyse the take-up rates of solar PV systems by households, using postcodes as a surrogate to assess distributional efficiency. Studies are reported to conclude that there have been comparatively low take-up rates in the lower north, inner west and eastern suburbs of Sydney, whereas there has been a more widespread take-up of solar PV systems in outer Western Sydney suburbs. At face value, this would logically lead one to conclude that Solar PV system installations may actually have a bias towards lower income households. But utilising postcodes to draw such conclusions relies on an especially blunt variable as incomes vary across and within suburbs.

Detailed survey data from AGL Energy Ltd in relation to its customer base reveals very different conclusions. Results of this survey data, which follow in *Figures 2* and *3*, relate to a sample of 870 customers equipped with solar PV units. The size and makeup of the sample provides unique insights on distributional impacts of FiT and potentially the incidence of the tax:

Figure 2: Solar PV Take-Up Distribution by Household Income

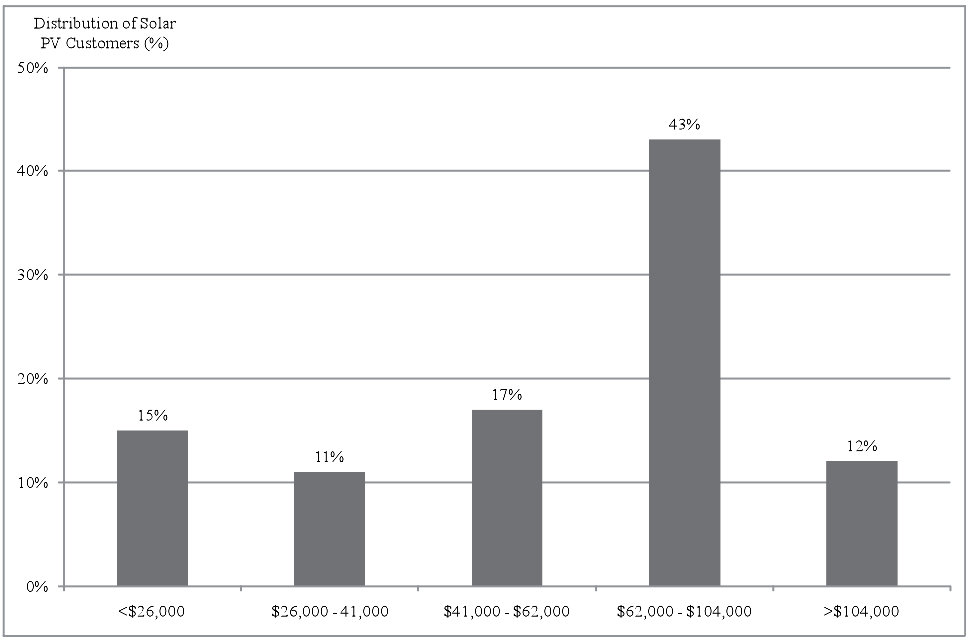
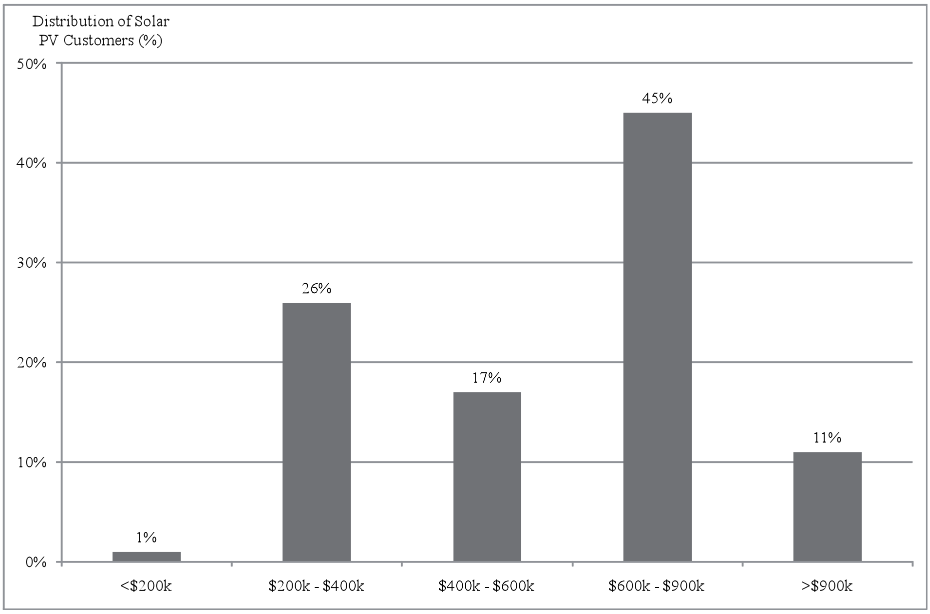


Figure 2 clearly illustrates that 55% of solar PV customers earn an annual income of greater than $62,000 pa, whereas only 15% of customers would be classed as low income, i.e. an annual income less than $26,000 pa. *Figure 3* analyses the same customer base by house price:

Figure 3: Solar PV Take-Up Distribution by House Price



Once again, we find that when assessing the value of the housing stock which has opted-in to the GFiT, 56% of the sample holds real property worth $600,000 or more. Such data tends to dispel any suggestion that low income households are somehow over-represented in the GFiT scheme.

To analyse the effective tax rate weighted by consumption and income bracket, we have established a weighted average annual cost per household, by income bracket. The results in relation to the GFiT and NFiT policy parameters described earlier are presented in *Table 3*.

Table 3: Impacts of GFIT and NFiT on Annual Bills and Implied Tax Rates

Household Income (before tax)	GFiT		NFiT	
	Weighted Average Cost Per Household	Implied Median Income Taxation Rate	Weighted Average Cost Per Household	Implied Median Income Taxation Rate
Up to $33,800	30.34	0.089	6.67	0.019
$33,800 – $62,400	35.90	0.074	7.89	0.016
$62,400 – $130,000	42.93	0.044	9.44	0.009
More than $130,000	44.85	0.034	9.86	0.007
Not disclosed	39.67	N/A	8.72	N/A

Based upon the analysis presented in *Table 3*, there is a correlation between the weighted average cost per household and household income, but the incremental costs are substantially smaller than the increases in income. Accordingly, the implied rate of taxation is *inversely* correlated with income. Alternatively put, both the GFiT and NFiT are highly regressive in nature. In fact, the implied rate of taxation is 2.6 times higher for households in the lowest income bracket (0.089%) than the higher income bracket (0.034%).[13] This regressive form of indirect taxation is, in our view, a very poor public policy outcome for three principal reasons:

1. The households least able to afford the upfront capital costs associated with installing solar PV are those that pay the highest effective rate of taxation. As such, in addition to being a regressive form of taxation, FiT are a cross subsidy of wealth from lower income households to higher income households.
2. Alternative policies exist which provide similar outcomes in relation to the production of new renewable energy which do not result in the same perverse outcomes from a social equity perspective. Other mechanisms for supporting renewable energy, such as LRET, are not regressive in nature. These mechanisms ensure that all consumers benefit through the provision of renewable energy. Each consumer effectively captures the costs and benefits of renewable energy in proportion to their energy spend. In contrast, the renewable energy produced and consumed as a result of GFiT and NFiT solely benefits the individual household where the solar PV unit is installed.
3. The 'absolute' nature of having the title deed to property as the single biggest eligibility criteria. Only households that own their own home can install solar PV systems. As such, the proportion of the population that is incurring the highest incidence of taxation, those renting, are unlikely to be able to take advantage of the policy.

To contrast the regressive nature of GFiT and NFiT arrangements, we note that the effective rate of taxation would be significantly progressive if general government revenues were used to fund GFiT and NFiT policies. Of the $328 billion in revenue expected to be raised by the Commonwealth Government in 2010/11, individual income tax will comprise about 42% or $137 billion. And importantly, individual income tax in Australia is progressive with rates increasing from zero for individuals earning up to $6,000 per annum, and up to 45% for individuals earning over $180,000 (Treasury, 2010).

Our analysis has focused on NSW data. We have no reason to believe that relative electricity consumption by household income bracket would exhibit dissimilar characteristics in other jurisdictions, viz. QLD, VIC, ACT, and SA. Accordingly, from this we conclude that Australian FiT policies fundamentally fail the first of our criterion for optimal public policy. FiT policies within Australia, which are funded through higher tariffs on all other electricity consumers, are fundamentally regressive.

Industry and media analysts have recently indicated that the pressure of higher general electricity prices, related to the funding of solar PV installations, has resulted in governments

[13] The regressive nature is probably understated due to the electricity load in higher income households being lower due to their electricity needs being met by solar PV systems. This results in less costs being incurred by these higher income households with lower income households funding the difference.

shifting the costs away from electricity tariffs and back to government (Hepworth, 2011). On 1 February 2011, the NSW Government announced that the FiT in NSW would be funded by the NSW Government through the use of unallocated monies from its Climate Change Fund (Keneally 2011). While this appears on the surface to be a positive recognition of the regressive nature of these polices, little attention has been paid to replacement funding. The NSW Climate Change Fund is created through a levy on state-owned electricity distributors in NSW. These distributors have passed these costs through to consumers with the permission of regulatory bodies. As such, even when regressive funding options for solar PV are displaced, the adopted alternative has the same regressive features.

5.2 Long-Term Stability for the Development of Solar PV Industry Capacity

Australian FiT policies have not in all cases been stable. At the extreme end of instability in relation to industry development has been the NSW GFiT policy. It was initially set at an excessive level of \$600/MWh for all generation. To put the extent of this level into context, a 3 bedroom cottage in Sydney without air conditioning might typically consume 1.9 MWh over a 95 day billing period over summer at a total cost of about \$325 under a standard time-of-use tariff. Equipped with a 1.5kW solar PV unit, output would be about $^1/_3$ of the 1.9MWh household consumption, yet will produce about \$400 of income under the GFiT; thus the household account will actually be in credit for about \$75.

With such a generous rebate system, predictably, the NSW GFiT was extensively oversubscribed, and in time, was subject to significant downward revisions to dampen demand. This in turn caused considerable shock to industry development. In the first instance, the tariff was reduced from \$600 to \$200/MWh in late-2010 when the legislated 50 MW aggregate installation cap was anecdotally reached. Industry rumours indicated that on the evening that the \$600/MWh Gross FiT policy was to be abandoned, more than 50MW of household solar PV system orders were placed for processing, which would add substantially to the existing c.140MW of solar PV systems in NSW and c.500MW Australia-wide. The NSW Government announced in early-2011 that its' entire FiT scheme would "close" to any future households when 300 MW of aggregated capacity was installed. Of greatest concern to investors in the industry was the mechanism for ending the scheme; households would only be able to discover *after* the purchase of their system whether they would be eligible or ineligible for the revised \$200/MWh tariff (Keneally, 2011).

At the other end of the policy spectrum, the FiT policies utilising net tariffs (SA, QLD, VIC) are better placed at providing stable industry development as the payback periods are measured and require a minimum investment by the householder. A key benefit of the stability provided by these policies (and the small-scale renewable energy certificate incentive under the SRES) is the potential for installers to lock in long-term contracts. The potential to hedge price risk provides for a more stable setting in which industry can manage the costs (and subsidies) for installing solar PV.

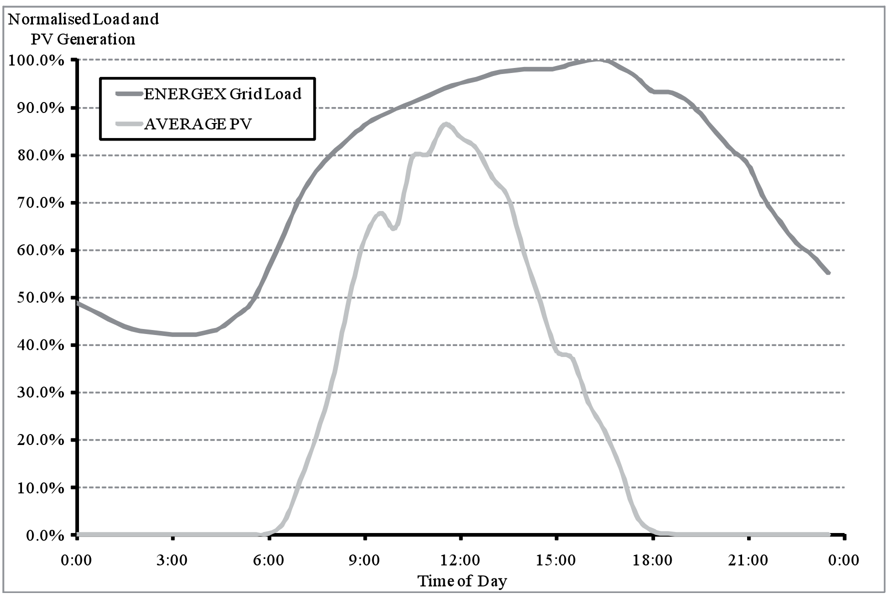
5.3 Structuring FiT to Capture any Benefits to Network Congestion/Augmentation

As flat rate payments, it would appear that none of the FiT policies in Australia satisfy this criterion. In its 2009 Demand Side Participation Review, the Australian Energy Market Commission concluded that distributed (or embedded) generation "has the potential to avoid costs in the distribution and transmission networks" (AEMC 2009, p.47). Whilst most jurisdictions require retailers to offer fair value for any energy exported from a solar PV system, we are not aware of any analysis by policy makers addressing the question of whether distributed solar PV systems provides network benefits or not.

This is a critical observation when one considers issues associated with inefficient spending on network augmentation as a result of the differentiation of underlying energy demand and peak demand. Nelson et al. (2010) outlined that the ratio of peak demand to underlying energy demand throughout eastern Australia varies up to 180%. The result of this 'two-speed' demand growth is a worsening utilisation rate of infrastructure and inefficient capital expenditure. Simshauser, Nelson and Doan (2011b) demonstrated that network prices are the primary driver of higher electricity prices throughout much of Australia. The failure of any of Australia's FiT policies to examine this issue in any detail appears to be another oversight by policy makers.

Conversely, it may be that the analysis has been undertaken and simply not revealed. Output from the roughly 90MW of solar PV systems installed in SE QLD has recently been analysed by Energex and compared with peak period demand. This analysis seems to reveal a structural misalignment with demand, as *Figure 4* notes:

Figure 4: Solar PV Output vs. Day of Peak Demand in SE QLD (15 Feb 2010)[14]



Source: Energex (2010).

14 We are grateful to Energex CEO Terry Effeney for providing us with the underlying data. This data has been drawn from a forthcoming report prepared by Evens & Peck for Energex Ltd.

Figure 4 illustrates that maximum output from existing SE QLD solar PV systems occurs at 11:30am whereas system peak demand occurs at around 4:30pm in the afternoon. Whether this analysis of SE QLD demand is representative of other regions is unclear. But regardless, no attempt to analyse the matching of output and household demand appears to have been made in the determination of FiT policies.

Assessed against these three core criteria, it is apparent that current FiT policies are sub-optimal. There is considerable room for progress towards improvement, firstly through better institutional arrangements, secondly through structuring the tariff, and of course identifying more appropriate (i.e. progressive) funding sources for ongoing FiT schemes.

VI. POLICY IMPLICATIONS AND CONCLUSION

There has been a proliferation of policies developed by State and Territory governments within Australia aimed at stimulating investment in small-scale residential solar PV installations. These policies have resulted in substantial numbers of solar PV systems being installed, our estimate being c.500MW across Australia, but there has been little focus on the costs and benefits, nor whether the policies have unintended consequences in relation to equity and industry development.

We have argued that there are three criteria within which FiT policies should be assessed: whether policy funding is progressive or regressive; the ability of the policy to stimulate long-term, rather than short-term cyclical industry development; and whether the policy captures distributed generation benefits. Most problematic was the assessment against the first criteria. All policies were found to be significantly regressive in nature with the effective rate of taxation paid by low income households being almost three times higher than high income households. While there are some examples of FiT policies that were designed as a way of incentivising long-term stable development of the industry, none of the policies analysed the last of the criteria in relation to specific design related to network benefits. It may be that none actually exist, but no evidence of such analysis could be located.

Our analysis tends to conclude that there is insufficient evidence to support the ongoing retention of FiT policies in Australia. These policies, in contrast to policies where the benefits are spread across the entire customer based (e.g. LRET), internalise the benefits for wealthy households and result in a disproportionate higher effective taxation rate on lower income households. Based upon an assessment against our policy criteria above, we believe that FiT policies should be gradually reduced and eliminated. The SRES is a good example of a sensible short-term policy initiative that provides initial support but is designed to decay over time. If governments believe there are public policy grounds for continued support of residential solar PV, the conclusion from our analysis is that alternatives to current FiT policies should be considered. Modest capital grants, funded by progressively raised taxation, would be preferable as they would overcome the perverse social outcomes highlighted in this article. Perhaps the best summary of why FiT policies should not be pursued has been articulated by the Commonwealth Government's Minister for Energy and Resources, Martin Ferguson MP, when he stated in Parliament:

> "Premium Feed-in Tariffs create an additional burden on electricity consumers, particularly those that cannot afford to install renewable energy systems but pay higher electricity prices to cross-subsidise those that can afford such systems."

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